GCE AS

Physics

Summer 2009

Mark Schemes

Issued: October 2009

NORTHERN IRELAND GENERAL CERTIFICATE OF SECONDARY EDUCATION (GCSE)
AND NORTHERN IRELAND GENERAL CERTIFICATE OF EDUCATION (GCE)

MARK SCHEMES (2009)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

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Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 1

assessing

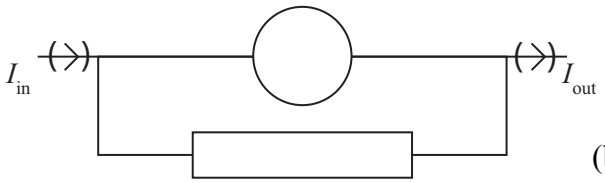
Module 1: Forces and Electricity

[ASY11]

TUESDAY 16 JUNE, AFTERNOON

MARK SCHEME

						AVAILABLE MARKS
1	**(a)**	**(i)**	Scalar quantity has magnitude (or size) **only** [1]			
		(ii)	**Displacement**, **force**, **momentum** 2 marks, [$-\frac{1}{2}$] each mistake, round down [2]	[3]		
	(b)	1.	Resultant of all the forces is zero **or** sum of the components of forces in two perpendicular directions is zero **or** forces, taken in order, form closed polygon [1]			
		2.	Resultant moment of the forces is zero **or** (sum of) clockwise moments = (sum of) anticlockwise moments (about any point) [1]	[2]		
	(c)		$200 \sin 35 = F \sin \theta = 115\,\text{kN}$ [1] $F \cos \theta + 200 \cos 35 = 250\,\text{kN}$ [1] $F \cos \theta = 86\,\text{kN}$ [1] $\tan \theta = \frac{115}{86}$ $\boldsymbol{\theta = 53°}$ [1] $\boldsymbol{F = 143\,\text{kN}}$ [1] **or** Graphical: triangle with arrows [1], sensible scale [1], identify θ [1] $\boldsymbol{\theta}$ **in range 50 ° to 56 °** F in range **137 kN to 149 kN** [2]	[5]		10
2	**(a)**	**(i)**	Moment of a force about a point is the product of the force and the perpendicular distance from the line of action of the force to the point [1] **or** from clearly labelled diagram			
		(ii)	Newton metre (or N m) or kg m^2 s^{-2} [1]	[2]		
	(b)	**(i)**	Magnitude = 175 – 50 = **125 N** [1] **Vertically upwards or arrow upwards** [1] "North" [0]	[2]		
		(ii)	$50 \times 1.4 = 175 \times Z$ (ground to CG) [1] $Z = 0.4\,\text{m}$ [1] **Distance = 1.0 m** [1]	[3]		7
3	**(a)**	**(i)**	Horizontal component $= \frac{25}{1.4} =$ **18 (17.9) m s^{-1}** [2]			
		(ii)	Vertical component: $u = v - at$ $u = 0 - (-9.8) \times 1.4$ [1] $= 14\,(13.7)\,\text{m s}^{-1}$ [2]	[5]		
	(b)	**(i)**	Velocity $= \sqrt{(17.92^2 + 13.72^2)}$ (**or** e.c.f. from **(a)**) [1] $=$ **23** $(22.5)\,\text{m s}^{-1}$ [1]	[2]		
		(ii)	$\tan \theta = \frac{13.7}{17.9}$ [1] $\theta =$ **37 (37.4 °)** (**or** e.c.f. from **(a)**) [1]	[2]		
		(iii)	$v^2 = u^2 + 2as$ **or** from $s = ut + \frac{1}{2}at^2$ $0 = 13.7^2 + 20H$ subs [1] $H =$ **9.6 m** ans [1]	[2]		11

						AVAILABLE MARKS
4	**(a)**	**(i)**	Mass (of a body) times (its) velocity	[1]		
		(ii)	Applied force multiplied by the time for which it acts **Not** "change in momentum" or merely "force × time"	[1]	[2]	
	(b)	**(i)**	Magnitude = $\mathbf{2.55 \times 10^{-23}}$ Unit: **kg m s^{-1}** or **N s**	[1] [1]		
		(ii)	Impulse = $\mathbf{5.10 \times 10^{-23}}$ SI units	[2]	[4]	6
5	**(a)**		EMF is the potential difference across the output terminals of the source when no current is being drawn from it **or** formal definition Terminal potential difference is the voltage across the terminals when a current is being drawn from the source	[1] [1]		
			Quality of written communication	[1]	[3]	
	(b)	**(i)**	Opposition to current flow through the electrical power source **Allow** "Resistance of chemicals in battery or of components of power source"	[1]		
		(ii)	$E = I(R + r)$ $\boldsymbol{E - V = Ir}$	[1] [1]		
		(iii)	External load resistance = internal resistance **or** $R = r$	[1]	[4]	7
6	**(a)**	**(i)**	Shows left pair have combined resistance **15 Ω** and right pair **16 Ω**, **adding** to 31 **Ω**	[1] [1] [1]		
		(ii)	Total resistance = $\frac{12}{0.3}$ [1] = **40 Ω** (10^n error, using 300 mA, 0.04 **Ω** [1])	[2]		
		(iii)	$R = 40 - 31 =$ **9 Ω or** e.c.f.	[1]		
		(iv)	Resistance ratio = inverse of current ratio Current = **100 mA**	[1] [1]	[8]	
	(b)	**(i)**	 (battery directly across meter, [0])	[1]		
		(ii)	$200 \times 600 =$ $800 \times R_s$ **or** $\left(200 \times 10^{-6} \times 600 = 800 \times 10^{-6} \times R_s\right)$ $R_s =$ **150 Ω**	[1] [1] [1]	[4]	12

					AVAILABLE MARKS
7	**(a)**	Voltage ratio or current evaluation	[1]		
		$R_x = \mathbf{200\,\Omega}$	[1]		
		$R_y = \mathbf{300\,\Omega}$	[1]	[3]	
	(b)	For 5.0 V, A must be $\frac{1}{3}$ up from bottom	[1]		
		300 Ω in parallel with $\frac{1}{3}$ of R_y giving combined resistance of 75 Ω	[1]		
		$V_o = \frac{25 \times 75}{475}$	subs [1]		
		$V_o = \mathbf{3.95\,V}$	[1]	[4]	7
			Total		**60**

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

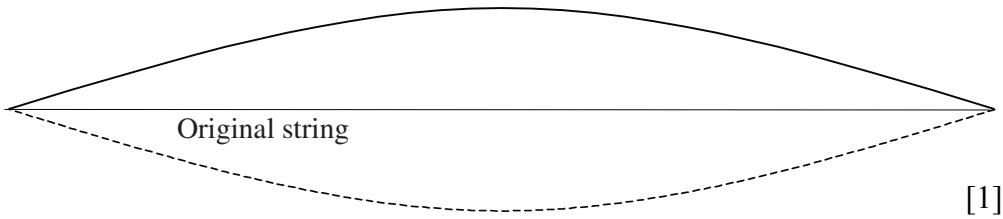
Assessment Unit AS 2

Module 2: Waves and Photons

[ASY21]

FRIDAY 19 JUNE, MORNING

MARK SCHEME

					AVAILABLE MARKS
1	**(a)**	L to R: TV/Radio, micro, IR, Visible, UV, X, gamma (Reverse order [2]/[3]) (7 names present, wrong order [1]/[3])		[3]	
	(b)	Any value between **400 & 700 nm** (unit must be present)		[1]	
	(c)	$c = f\lambda$	[1]		
		$3 \times 10^8 = 620 \times 10^9 \lambda$	[1]		
		$\lambda =$ **4.84** $\times$ **10^{-4}** m (no s.f. penalty)	[1]	[3]	7
2	**(a)**	Diagram to show labelled (i) glass block (any shape)	[1]		
		(ii) ray box	[1]	[2]	
	(b)	Direct ray onto glass block at **different angles**	[1]		
		Join the entering and emerging rays	[1]		
		Measure the incident and refracted angles	[1]	[3]	
	(c)	**(i)** sin i v sin r	[1]		
		Straight line through origin (labelled 1)	[1]	[2]	
		(ii) Slope change consistent with their axes (labelled 2) (Neither line labelled, [2]/[3])		[1]	8
3	**(a)**	3rd mode/3rd harmonic/2nd overtone		[1]	
	(b)	correctly labelled antinode		[1]	
	(c)	Wavelength = **0.16** (m)		[1]	
	(d)			[1]	
	(e)	**(i)** $F = \frac{1}{3}$ } Any unit [–1] each time		[1]	
		(ii) $W = \frac{1}{3}$		[1]	6

					AVAILABLE MARKS
4	**(a)**	Spreading of waves (**not** bending)	[1]		
		Passing through an aperture/passing by an obstacle/ into geometric shadow	[1]	[2]	
	(b)	Linear wave fronts with slight spreading at edges	[1]		
		Constant wavelength	[1]		
		Lengthening wave fronts	[1]	[3]	
	(c)	Wavelength of sound > wavelength of light	[1]		
		Diffraction spreading proportional to or related to wavelength or wavelength of sound ≈ width of open door	[1]		
		Greater diffraction of sound than light	[1]	[3]	
		QWC Legible text, accurate SPG		[1]	9
5	**(a)**	Points: 3.21 3.61 3.88 5.38 6.02 (4 or 5)	[1]		
	(b)	Points (4 or 5)	[1]		
		Best-fit line from their points	[1]	[2]	
	(c)	Large triangle (i.e. one side, vertical or horizontal ≥ 5 cm)	[1]		
		Consistent value	[1]		
		m s^{-1} or Hz m	[1]	[3]	
	(d)	Gradient = $v/4$	[1]		
		Quality **325–375** m s^{-1}	[1]	[2]	8
6	**(a)**	A packet of electromagnetic energy or a particle of light or light quantum		[1]	
	(b)	Use of $E = hf$	[1]		
		$E = 6.63 \times 10^{-34} \times 6.00 \times 10^{16}$	[1]		
		$E =$ **3.98 × 10^{-17}** (J)	[1]	[3]	
	(c)	Emission of an electron [1] (from metal) due to absorption of em/uv radiation [1] (incident upon the metal)	[2]		
		Occurs when photon energy > metal work function **or** when photon frequency > threshold frequency	[1]	[3]	7

						AVAILABLE MARKS
7	**(a)**	**(i)**	Most electrons in excited state (Some in excited state but fewer than half [1]) (**not** in between, [0]/[2])		[2]	
		(ii)	**Population inversion**		[1]	
	(b)		A (passing) photon of the same/correct frequency/energy/wavelength		[1]	
	(c)		193 nm converted to 193×10^{-9} m or equivalent	[1]		
			Photon energy = 1.03×10^{-18} J	[1]		
			Photon energy = 6.44 eV	[1]		
			Energy level = **–2.74** eV (must have minus sign) ((–)15.6 eV, [3]/[4])	[1]	[4]	8
8	**(a)**		Wavelength, Planck constant, momentum or mass × velocity		[1]	
	(b)		**1.51×10^{33}** (Stating $1/h$ [1])	[2]		
			$J^{-1}\ s^{-1}$ or **$N^{-1}\ s^{-1}\ m^{-1}$**	[1]	[3]	
	(c)		$\lambda = 6.63 \times 10^{-34}/(0.9 \times 3.00 \times 10^{8} \times 9.11 \times 10^{-31})$ correct use of 0.9 [1] other subs [1]	[2]		
			$\lambda =$ **2.70×10^{-12}** (m)	[1]	[3]	7
					Total	**60**

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 3A

assessing

Module 3A: Medical Physics

[ASY31]

FRIDAY 19 JUNE, MORNING

MARK SCHEME

						AVAILABLE MARKS
1	**(a)**	**(i)**	lens [1] **ciliary** muscles [1] (ignore any additional items)		[2]	
		(ii)	Thickness (or *f*) of the lens adjusted [1] by (contraction of) ciliary muscles [1]		[2]	
	(b)		Controlled by **iris** [1] Bright light, pupil gets smaller **or** dim light, gets larger [1]		[2]	
	(c)	**(i)**	**400 nm–700 nm**		[1]	
		(ii)	**Cones** responsible as receptors [1] red, green and blue cones (stimulated different amounts) [1] Adding of information from each type leads to perception of colour with a dominant wavelength **or** combined effect of all 3 cone types gives colour sense [1] (Graph must be explained for credit)		[3]	10
2	**(a)**		Position furthest from the eye that an object may be viewed clearly		[1]	
	(b)	**(i)**	diverging/concave		[1]	
		(ii)	Use of lens eqn (any signs) [1] $\frac{1}{\infty} - \frac{1}{1.2} = \frac{1}{f} = P$ Lens power needed = **–0.833** [1] (correct minus sign in –1.2 and –0.833) Unit: **D or m^{-1}** [1]		[3]	
		(iii)	Identifies *v* as near point [1] $\frac{1}{u} - \frac{1}{0.15} = -\frac{1}{1.2}$ subs with correct signs [1] Near point distance = **0.17 m** [1]		[3]	8
3	**(a)**	**(i)**	The minimum intensity which can be detected (by a person with normal hearing)		[1]	
		(ii)	• Intensity – the energy of the sound wave arriving at the ear per second per m^2 • Intensity level is a comparison of intensity with a reference value • Reference value = threshold of hearing • Intensity measured in Wm^{-2}, intensity level in dB Any **three** points		[3]	
	(b)		Intensity at 37.0 dB = 5.01×10^{-9} (Wm^{-2}) [1] [1] 76.0 dB = 3.98×10^{-5} (Wm^{-2}) [1] [1] Factor = **7900, 8000** [1]		[3]	7

					AVAILABLE MARKS
4	**(a)**	Vertical axis labelled, e.g. 10^{-14}, 10^{-12} ... in log progression	[1]		
		correct shape (U-shape, not below 10 Hz, not above 100 000 Hz)	[1]		
		Intensity minimum **10^{-12} Wm^{-2} at 2 kHz** approx	[1]	[3]	
	(b)	**(i)** Two physical/physiological/psychological effects	[1]		
		e.g. deafness, blood pressure, respiratory rate, digestive system, concentration	[1]	[2]	
		(ii) In range **85 dB–95 dB**		[1]	
	(c)	Music level lower, less hearing damage	[1]		
		Safety hazard because less likely to hear traffic noise	[1]	[2]	8
5	Non-coherent:				
	(a)	**(i)** The fibres are arranged randomly at each end **or** no spatial alignment of the fibres at the ends		[1]	
		(ii) Non-coherent: provides illumination for viewing	[1]		
		Coherent: transmits an image from one end to the other	[1]	[2]	
	(b)	Account points from			
		1. External r.f. radiation scanned	[1]		
		2. Resonance in hydrogen atoms in body	[1]		
		3. Hydrogen atoms change orientation in magnetic field	[1]		
		4. Changes in magnetic field detected	[1]		
		5. r.f. receiver detects changes	[1]		
		6. Signals applied to computer for analysis	[1]		
		7. High magnetic fields (2T) required This is a difficulty in magnitude and/or cost	[1]		
		8. Special accommodation required for magnet	[1]		
		9. Precautions must be taken by persons in proximity of magnet, e.g. jewellery, credit cards, pacemakers Only [1] maximum for precaution	[1]		
		10. **or** any other valid point, e.g. scanner moves round to give 3-D image claustrophobia			
		Any [8]		[8]	
		Quality of written communication		[1]	12
				Total	**45**

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 3B

assessing

Module 3B: Experimental and Investigative Skills
Session No. 1

[ASY32]

WEDNESDAY 13 MAY, MORNING

MARK SCHEME

					AVAILABLE MARKS
1	**(a)**	Sets up circuit without assistance		[3]	
	(b)	Results **Table 1.1**			
		5 or more pairs of values	[3]		
		(4 pairs [2], 3 pairs [1])			
		Consistent d.p. throughout (but allow 0, 0)	[1]		
		(not within 3–10 V range, [–1])		[4]	
	(c)	**(i)** *x*-axis $\boldsymbol{V_{in}}$; *y*-axis $\boldsymbol{V_{out}}$ (or *vice versa*)		[1]	
		(ii) $\boldsymbol{R_1/(R_1 + R_2)}$ (or inverse)		[1]	
		(iii) **zero** *or* **0** *or* **origin**		[1]	
	(d)	Axes, labels and units	[1]		
		Workable scales using at least half each axis	[1]		
		Plots five points to ±2 mm square ([–1] each error)	[2]		
		Best-fit line	[1]	[5]	
	(e)	**(i)** Large triangle (more than 5 cm on one side)	[1]		
		Correct read-offs from candidate's graph and subs into gradient expression	[1]		
		Quality: **in range 0.52 to 0.58** (**1.92 to 1.72** for inverse)	[1]	[3]	
		Unit: **No unit**		[1]	
		(ii) Equates candidate's responses to **(c)(ii)** and **(e)(i)**	[1]		
		Correct solution of candidate's values (guide 680 Ω)	[1]	[2]	
	(f)	**(i)** 2.44 ± 0.02 is 0.8(2)%	[1]		
		1.56 ± 0.01 is 0.6(4)%	[1]		
		Adds % uncertainties: **1.4%**, **1.46%** *or* **1.5%**	[1]	[3]	
		(ii) Not worth it because gain in accuracy negligible compared with ±10% in R_1		[1]	25

					AVAILABLE MARKS
2	**(a)**	Trace **C**	[1]		
		Because node is minimum/quiet sound, hence smallest amplitude trace *or* equivalent	[1]	[2]	
	(b)	**(i)** $\lambda = 2x$		[1]	
		(ii) Microphone and/or speaker moved	[1]		
		Normally to plane of reflecting surface (allow "towards microphone/speaker")	[1]		
		Adjust microphone/speaker position until node/antinode identified	[1]		
		Move through number n of node–node/antinode–antinode distances (allow $n = 1$)	[1]		
		Measure distance moved d	[1]		
		$\lambda = 2d/n$ (if $n = 1$, must repeat and average)	[1]	[6]	
		Quality of written communication: ⩽ 3 spg errors		[1]	
	(c)	**(i)** Change frequency, obtain new wavelength	[1]		
		Repeat until at least five f, λ pairs obtained	[1]	[2]	
		(ii) λ versus $1/f$ or other permutation: each axis [1]		[2]	
		(iii) v = gradient *or* 1/gradient, as appropriate for axes		[1]	
	(d)	Find difference Δ in gradients	[1]		
		Take Δ/best-fit line gradient	[1]		
		Multiply by 100 for %	[1]	[3]	
	(e)	Uncertainty decreases/accuracy increases	[1]		
		Because nodes sharper, hence easier to locate/can count more of them	[1]	[2]	20
				Total	**45**

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 3B

assessing

Module 3B: Experimental and Investigative Skills
Session No. 2

[ASY33]

THURSDAY 14 MAY, MORNING

MARK SCHEME

					AVAILABLE MARKS
1	**(a)**	Sets up circuit without assistance		[3]	
	(b)	Results **Table 1.1**			
		5 or more pairs of values	[3]		
		(4 pairs [2], 3 pairs [1])			
		Consistent d.p. throughout (but allow 0, 0)	[1]		
		(not within 3–10 V range, [–1])		[4]	
	(c)	**(i)** *x*-axis $\boldsymbol{V_{in}}$; *y*-axis $\boldsymbol{V_{out}}$ (or *vice versa*)		[1]	
		(ii) $\boldsymbol{R_1/(R_1 + R_2)}$ (or inverse)		[1]	
		(iii) **zero** *or* **0** *or* **origin**		[1]	
	(d)	Axes, labels and units	[1]		
		Workable scales using at least half each axis	[1]		
		Plots five points to ±2 mm square ([– 1] each error)	[2]		
		Best-fit line	[1]	[5]	
	(e)	**(i)** Large triangle (more than 5 cm on one side)	[1]		
		Correct read-offs from candidate's graph and subs into gradient expression	[1]		
		Quality: **in range 0.26 to 0.32** (**3.1 to 3.9** for inverse)	[1]	[3]	
		Unit: **No unit**		[1]	
		(ii) Equates candidate's responses to **(c)(ii)** and **(e)(i)**	[1]		
		Correct solution of candidate's values (guide 820 Ω)	[1]	[2]	
	(f)	**(i)** 9.61 ± 0.02 is 0.2(1)%	[1]		
		1.49 ± 0.01 is 0.67%, 0.7%	[1]		
		Adds % uncertainties: **0.88%** *or* **0.9%**	[1]	[3]	
		(ii) Not worth it because gain in accuracy negligible compared with ±10% in R_1		[1]	25

					AVAILABLE MARKS
2	**(a)**	Trace **D**	[1]		
		Because antinode is maximum/loud sound, hence largest amplitude trace *or* equivalent	[1]	[2]	
	(b)	**(i)** $\lambda = 2x$		[1]	
		(ii) Microphone and/or speaker moved	[1]		
		Normally to plane of reflecting surface (allow "towards microphone/speaker")	[1]		
		Adjust microphone/speaker position until node/antinode identified	[1]		
		Move through number n of node–node/antinode–antinode distances (allow $n = 1$)	[1]		
		Measure distance moved d	[1]		
		$\lambda = 2d/n$ (if $n = 1$, must repeat and average)	[1]	[6]	
		Quality of written communication: ⩽ 3 spg errors		[1]	
	(c)	**(i)** Change frequency, obtain new wavelength	[1]		
		Repeat until at least five f, λ pairs obtained	[1]	[2]	
		(ii) λ versus $1/f$ or other permutation: each axis [1]		[2]	
		(iii) v = gradient *or* 1/gradient, as appropriate for axes		[1]	
	(d)	Find difference Δ in gradients	[1]		
		Take Δ/best-fit line gradient	[1]		
		Multiply by 100 for %	[1]	[3]	
	(e)	Uncertainty decreases/accuracy increases	[1]		
		Because nodes sharper, hence easier to locate/can count more of them	[1]	[2]	20
				Total	**45**